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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/659,934	09/11/2003	Tao Wu	042933/267065	5056

826 7590 10/18/2010

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EXAMINER	
DAILEY, THOMAS J	

ART UNIT	PAPER NUMBER
2452	

MAIL DATE	DELIVERY MODE
10/18/2010	PAPER

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte TAO WU, SADHNA AHUJA,
and SUDHIR DIXIT

Appeal 2009-007742
Application 10/659,934
Technology Center 2400

Before JOHN A. JEFFERY, JAY P. LUCAS, and JAMES R. HUGHES, *Administrative Patent Judges*.

JEFFERY, *Administrative Patent Judge*.

DECISION ON APPEAL[1]

Appellants appeal under 35 U.S.C. § 134(a) from the Examiner's rejection of claims 1-5, 7-12, 14-19, 21, 22, 24-29, 31, 32, and 34-38. Claims 6, 13, 20, 23, 30, and 33 have been canceled. *See* Supp. App. Br. 2. We have jurisdiction under 35 U.S.C. § 6(b). We affirm-in-part.

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[1] The two-month time period for filing an appeal or commencing a civil action, as recited in 37 C.F.R. § 1.304, or for filing a request for rehearing, as recited in 37 C.F.R. § 41.52, begins to run from the "MAIL DATE" (paper delivery mode) or the "NOTIFICATION DATE" (electronic delivery mode) shown on the PTOL-90A cover letter attached to this decision.

STATEMENT OF THE CASE

Appellants invented a system, method, apparatus, and computer program product for decreasing latency in a wireless communications by providing proxy-based redirection of resource requests. *See generally* Spec. 1. Claim 1 is illustrative:

1. A system for requesting a resource over at least one network, the system comprising:

a terminal including a client application and configured to send a first request for the resource over a first network and a second network;

a host configured to receive the first request, and thereafter send a first response, wherein the first request identifies the resource at a first location on the host;

a network proxy configured to communicate with the host over the second network independent of the first network, wherein the network proxy is configured to receive the first response from the host, wherein the network proxy is configured to reformulate the first request into a second request that identifies the resource at a second location, and wherein the network proxy is configured to send the second request to a host of the resource at the second location such that the host of the resource at the second location responds to the second request with a second response; and

a terminal proxy configured to communicate with the client application independent of the first network, wherein the terminal proxy is configured to receive the first response and the second response from the network proxy, wherein the terminal proxy is configured to send the first response to the client application such that, in response to the first response, the client application reformulates the first request into a third request that identifies the resource at a second location, and wherein the client application is configured to send the third request to the terminal proxy such that the terminal proxy sends the second response to the client application.

The Examiner relies on the following as evidence of unpatentability:

Leppinen	WO 01/33804 A2	May 10, 2001

R. Fielding et al., *Hypertext Transfer Protocol - - HTTP/1.1* 1-3[2] (1999), *available at* http://www.ietf.org/rfc/rfc2616.txt ("Fielding").[3]

THE REJECTIONS

1. The Examiner rejected claims 15-19, 21, 25-29, and 31 under 35 U.S.C. § 102(b) as anticipated by Leppinen. Ans. 4-7.[4]

2. The Examiner rejected claims 1-5, 7-12, 14, 22, 24, 32, and 34-38 under 35 U.S.C. § 103(a) as unpatentable over Leppinen and Official Notice. Ans. 7-14.

CLAIM GROUPING

We group the claims as follows: (1) claims 15-19, 21, 25-29, and 31; (2) claims 1-5, 7-12, 14, 22, 24, and 35-37; (3) claim 32; (4) claim 34; and (5) claim 38.

Claims 15-19, 21, 25-29, and 31

THE ANTICIPATION REJECTION OVER LEPPINEN

Regarding independent claim 15, the Examiner finds that Leppinen discloses all recited elements, including a terminal including a "terminal proxy" because Leppinen's mobile station both receives a first and second response. Ans. 5. Appellants argue that Leppinen does not disclose the Examiner's elected first response (i.e., the new URL) includes a redirection

[2] Three printed pages of this reference were provided, and these page numbers correspond sequentially to the pages as they appear in the record.
[3] This reference is cited to teach an inherent property of HTTP messages that use HTTP/1.1 protocol. *See* Ans. 16-17.
[4] Throughout this opinion, we refer to (1) the Appeal Brief filed July 29, 2008 and supplemented August 27, 2008; (2) the Examiner's Answer mailed November 14, 2008; and (3) the Reply Brief filed January 8, 2009.

to the resource or that this redirection is sent to a proxy on the mobile station or terminal. App. Br. 9; Reply Br. 2-4.

The issue before us, then, is as follows:

ISSUE

Under § 102, has the Examiner erred in rejecting claim 15 by finding that Leppinen discloses a terminal that includes a terminal proxy and a processor configured to send the first response to the terminal proxy?

FINDINGS OF FACT

1. Appellants have not defined the term "terminal proxy." *See generally* Specification.

2. Leppinen discloses a system including a mobile station (MS) 12, a base station (BS) 14, a gateway server 16, and web server(s) 18. Leppinen, 5-6; Fig. 1.

3. Leppinen discloses a MS 12 has a Wireless Application Protocol (WAP) user agent that can communicate with web server 18 through gateway server 16. The user agent may be a micro web browser having features similar to a conventional web browser employed by a desktop computer terminal. Leppinen, 5.

PRINCIPLES OF LAW

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of Calif.*, 814 F.2d 628, 631 (Fed. Cir. 1987).

ANALYSIS

Based on the record before us, we find error in the Examiner's anticipation rejection of independent claim 15 which calls for, in pertinent part, a terminal that includes a terminal proxy and a processor configured to send the first response to the terminal proxy. Appellants have not defined the term "terminal proxy." *See* FF 1. As such, this term will be given its ordinary and customary meaning to an ordinarily skilled artisan at the time of the invention. *Phillips v. AWH Corp.,* 415 F.3d 1303, 1312-13 (Fed. Cir. 2005) (en banc). Accordingly, a proxy is "[a] computer (or the software that runs on it) that acts as a barrier between a network and the Internet by presenting only a single network address to external sites."[5] Thus, the claimed terminal proxy must be at least software that acts as a barrier between a network and the Internet by presenting only a single address to external sites. We therefore disagree with the Examiner's interpretation that a "terminal proxy" is any software (Ans. 15-16) or cache (Ans. 11-12) on a MS.

Leppinen discloses the MS or terminal includes a user agent (e.g., a browser). FF 3. As the browser allows a terminal's user to access web documents, Leppinen's browser is an interface between a terminal and network, including the Internet. However, this browser gives the user access to the network and Internet, and is not a barrier between the network and the Internet, such as a proxy. The Examiner has also not presented evidence that such a function would be inherent in the MS, its user agent, or any of its software applications. *See* Ans. 15-16. Additionally, Leppinen fails to

[5] Microsoft Press, *Microsoft® Computer Dictionary* 537 (5th ed. 2002) ("Microsoft").

discuss whether the browser (*see* FF 3) acts as a barrier that presents only a single address that protects the user agent in accordance with the definition of a proxy (*see* Microsoft, 537). Whether such a feature is probable in Leppinen's MS is insufficient to demonstrate that the Leppinen's MS necessarily includes a terminal proxy—a crucial requirement for inherent anticipation. *See In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999) (internal citations omitted).

Even if we were to interpret the term "proxy" more broadly to include software that substitutes for the terminal, we still find that Leppinen's user agent or browser does not substitute for the terminal since the browser, at best, provides access to view web documents and files. Leppinen's user agent, however, does not take the place of or substitute for any of the terminal's other functions. Moreover, because Leppinen fails to disclose a terminal proxy, Leppinen also fails to disclose a processor, contained within the gateway server 16 (*see* Ans. 5), is configured to or capable of sending the first and second response to the terminal proxy as recited in claim 15.

We are therefore persuaded that the Examiner erred in rejecting (1) independent claim 15; (2) independent claim 25 which recites commensurate limitations; and (3) claims dependent thereon for similar reasons. Since this issue is dispositive of our reversal of the Examiner's anticipation rejection, we need not address Appellants' other arguments pertaining to Leppinen (App. Br. 8-10; Reply Br. 2-4) or various dependent claims in connection with the anticipation rejection (App. Br. 10-11; Reply Br. 5-6).

THE OBVIOUSNESS REJECTION OVER LEPPINEN AND OFFICIAL NOTICE

Claims 1-5, 7-12, 14, 22, 24, and 35-37

Independent claims 1, 8, and 22 have language commensurate in scope to independent claim 15, including a terminal proxy that is configured to receive a first and second response. As noted previously, we are not persuaded that Leppinen discloses this feature. Nor has the Examiner shown that this feature would have been obvious to ordinarily skilled artisans, or that the Examiner's reliance on Official Notice cures this deficiency. We therefore will not sustain the rejection of independent claims 1, 8, and 22, and claims dependent thereon for the reasons indicated previously.

Claim 32

Independent claim 32 is broader in scope than the previously-discussed independent claims and does not recite a terminal proxy. The Examiner relies on the discussion of claim 22 (Ans. 12), which finds that Leppinen discloses all the limitations except for explicitly discussing the client application reformulates the first request into a third request (*see* Ans. 10-11). The Examiner takes Official Notice that, given Leppinen's teachings, any subsequent request would have been readily obvious to an ordinarily skilled artisan to be reformulated as recited. *See* Ans. 11-12. Appellants argue that Leppinen fails to teach a reformulation of the first request into a third request and challenges that the taking of Official Notice does not teach sending a third request in response to the first response as recited. App. Br. 11-14; Reply Br. 6-8.

The issue before us, then, is as follows:

ISSUE

Under § 103, has the Examiner erred in rejecting claim 32 by finding that Leppinen and Official Notice would have taught or suggested a second executable portion configured to send the first response to the first executable portion such that, in response to the first response, the first executable portion reformulates the first request into a third request?

FINDINGS OF FACT

4. Leppinen states that the MS 12 sends a message requesting content or a resource from the web server 18 (at 100) through gateway server 16. In step 102, the gateway server 16 transforms the request into a Uniform Resource Locator (URL) request (e.g., HyperText Transfer Protocol (HTTP) scheme) and sends the message to the web server 18. The web server 18 responds with a HTTP redirection message indicating a new location of the requested content in step 104. The gateway server 16 makes a new HTTP URL request containing the new URL according to the redirection message and directs the request to the same or different web server at step 106. At step 110, the gateway server 16 sends the requested content together with its new location (e.g., new URL for the requested content) back to the MS 12. The history file is updated with the new URL at step 112. Leppinen, 2, 6-7; Figs. 2A-B.

5. Leppinen discloses the message from the MS 12 and the requested content or resource to the MS can be coded in the Wireless Application Protocol (WAP). Leppinen, 2, 6-7.

ANALYSIS

Based on the record before us, we find no error in the Examiner's rejection of independent claim 32 which calls for, in pertinent part, a second executable portion configured to send the first response to the first executable portion such that, in response to the first response, the first executable portion reformulates the first request into a third request. At the outset, we note that this claim does not recite a terminal proxy, nor does it recite a redirection to a new resource. We therefore find that any argument regarding these features is not commensurate with the scope of the claims. *See* App. Br. 11-13.

As discussed above, Leppinen discloses a first executable portion (e.g., a user agent or browser) configured to send a first request for a resource (e.g., message requesting content) to a gateway server or network proxy. *See* FF 3-4. Leppinen's host (e.g., web server 18), in turn, sends a response with a new location (a HTTP redirection message from web server 18 indicates a new location for content) to a network proxy (e.g., gateway server 16). *See* FF 4. Additionally, Leppinen also discloses the host 18 eventually sends a first response (e.g., the new URL for the requested content) to the first executable portion (e.g., browser of the MS 12) through the gateway server 16 or second executable portion. Leppinen therefore discloses a second executable portion (e.g., at the gateway server 16) configured to communicate with the first executable portion as recited in claim 32.

Appellants contend that Leppinen and the Official Notice fail to teach the first executable portion reformulating the first request (e.g., message requesting content) into a third request in response to the first response as

recited. *See* App. Br. 12-13. We disagree. First, Leppinen teaches updating its file history with a new URL. *See* FF 4. Employing the creative steps and inferences of an ordinarily skilled artisan, Leppinen at least suggests that the new URL is stored within the first executable portion for future use by the MS 12. *See KSR Int'l. Co. v. Telefex, Inc.*, 550 U.S. 398, 418 (2007). Moreover, Leppinen suggests that, when a user of the MS 12 requests that resource later in time, the request (i.e., a third request) will be formulated differently from the first request (i.e., reformulated into a third request (e.g., message containing content at the new URL location)). *See* FF 4. Thus, even without taking Official Notice, Leppinen suggests that the first executable portion reformulates the first request into a third request, and this reformulation occurs using, or is in response to, the new URL for the requested content (i.e., the first response).

Moreover, for claim 32, the Examiner has only taken Official Notice that reformulating the first request into a third request or during a subsequent request is well known to an ordinarily skilled artisan (*see* Ans. 11-12)—not that the terminal client receives the first response and then formulates a third request received by the terminal proxy (*see* App. Br. 11-12). We agree with the Examiner. Due to the location change of the resource's content, future requests for this content on a MS will logically be reformulated to indicate the new location, and thus into new or third request. Leppinen and Official Notice therefore teach a second executable portion configured to send a first response to the first executable portion such that, in response to the first response (e.g., a new URL), the first executable portion reformulates the first request into a third request as recited in claim 32.

For the foregoing reasons, Appellants have not shown error in the obviousness rejection of independent claim 32, and we will sustain the rejection.

Claim 34

Claim 34 recites that the second executable portion is configured to (1) receive at least one of the first and second responses compressed, and (2) uncompress the response before sending the respective response to the first executable portion. The Examiner relies on the discussion regarding claim 7 (Ans. 14), which finds that Leppinen teaches compressing the responses in the steps 110 and 112 (*see* Ans. 13-14). Appellants argue that Leppinen fails to teach the new URL or requested resource is compressed before being sent the MS. App. Br. 15; Reply Br. 9.

The issue before us, then, is as follows:

ISSUE

Under § 103, has the Examiner erred in rejecting claim 34 by finding that Leppinen would have taught or suggested a second executable portion configured to receive a first or second compressed response?

ANALYSIS

Based on the record before us, we find no error in the Examiner's rejection of claim 34 which calls for, in pertinent part, a second executable portion configured to receive a first or second response compressed. First, we take Official Notice that compression techniques for transmitting data in

telecommunication systems are well known.[6] Additionally, Leppinen teaches the message from the MS 12 can be coded in the WAP, and the requested content or resource can also be coded using WAP to the terminal. *See* FF 5. Also, an ordinarily skilled artisan armed with Leppinen's teaching would have equally recognized that WAP can involve compacting or compressing the encoded format, including at the gateway server.[7] Leppinen thus would have suggested to an ordinary skilled artisan that a second executable portion (i.e., contained within gateway server 16) is configured to receive data in a coded format that is compressed and thus can receive compressed responses. *See id.* On this record, we therefore find that configuring the second executable portion (e.g., contained within Leppinen's gateway server 16) to receive compressed responses as recited would have been obvious. *See KSR*, 550 U.S. at 418.

For the foregoing reasons, Appellants have not shown error in the obviousness rejection of claim 34, and we will sustain the rejection.

Claim 38

Lastly, claim 38 recites the first response includes a redirection to the host of the resource at the second location. The Examiner finds that

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[6] *See In re Ahlert*, 424 F.2d 1088, 1091 (CCPA 1970) (explaining that "the Patent Office appellate tribunals, where it is found necessary, may take notice of facts beyond the record which, while not generally notorious, are capable of such instant and unquestionable demonstration as to defy dispute.")

[7] For example, WAP systems typically contain an encoded content into compact encoded formats. *See* Milan Gospic & Miroslav L. Dukic, *Mobile Datacom Networks*, 1 5th Int'l Conf. on Telecom. in Modern Satellite, Cable and Broadcasting Service 123, 123-24 (2001).

Leppinen teaches this feature in the steps 110 and 112. Ans. 14. Appellants argue that Leppinen's new URL is not redirection, and therefore does not contain a redirection to the resource at the new URL. App. Br. 14; Reply Br. 8-9.

The issue before us, then, is as follows:

ISSUE

Under § 103, has the Examiner erred in rejecting claim 38 by finding that Leppinen would have taught or suggested the first response includes a redirection to the host of the resource at the second location?

FINDINGS OF FACT

6. Appellants describe a response message 54 as a HTTP response message that includes a 3xx "Redirection" status code and other status codes. Spec. 12-13.

ANALYSIS

Based on the record before us, we find no error in the Examiner's rejection of claim 38 which calls for, in pertinent part, the first response includes a redirection to the host of the resource at the second location. While the Specification provides examples of a redirection (e.g., a 3xx status code), there is no definition for the term "redirection." *See* FF 6. Further, while Appellants argue that this term has a meaning inapposite to a URL, Appellants have not provided any evidence that the term "redirection" has a particular meaning to those of ordinary skill in the art. *See* App. Br. 9, 14. Since no special or particular meaning has been established for the term

"redirection," the term will be given its broadest reasonable interpretation. *See Am. Acad. Of Sci. Tech. Ctr.*, 367 F.3d 1359, 1364 (Fed. Cir. 2004). We therefore find the term "redirection" in this context includes an indicator that the resource has been redirected.

Leppinen teaches that the host (e.g., web server 18) sends a first response (e.g., new URL containing the new location) to the network proxy (e.g., gateway server 16). *See* FF 4. Additionally, the second executable portion (e.g., contained within the gateway server 16) receives this response and sends the new URL to the MS's first executable portion (e.g., web browser). *See id.* This first response contains a URL that contains a new location for a resource at a second location (i.e., indicating that the resource has been redirected to a new location). *See id.* Leppinen therefore teaches that the first response contains a redirection to the host of the resource at the second location as recited in claim 38.

Appellants also assert that Leppinen does not teach that the redirection response is sent to a proxy of the MS. App. Br. 14. But as stated previously regarding claim 32, this argument is not commensurate with the scope of dependent claim 38.

For the foregoing reasons, Appellants have not shown error in the obviousness rejection of claim 38, and we will sustain the rejection.

CONCLUSION

Under § 102, the Examiner erred in rejecting claims 15-19, 21, 25-29, and 31.

Under § 103, the Examiner did not err in rejecting claims 32, 34, and 38, but erred in rejecting claims 1-5, 7-12, 14, 22, 24, and 35-37.

ORDER

The Examiner's decision rejecting claims 1-5, 7-12, 14-19, 21, 22, 24-29, 31, 32, and 34-38 is affirmed-in-part.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv).

AFFIRMED-IN-PART

rwk

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EVIDENCE APPENDIX

Microsoft Press, *Microsoft® Computer Dictionary* 537 (5th ed. 2002).

Milan Gospic & Miroslav L. Dukic, *Mobile Datacom Networks*, 1 5th Int'l Conf. on Telecom. in Modern Satellite, Cable and Broadcasting Service 123 (2001).

Notice of References Cited

Notice of References Cited	Application/Control No. 10/659,934	Applicant(s)/Patent Under Reexamination
	Examiner	Art Unit 2400 / Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification	
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FOREIGN PATENT DOCUMENTS

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NON-PATENT DOCUMENTS

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	U	Microsoft Press, Microsoft® Computer Dictionary 537 (5th ed. 2002).
	V	Milan Gospic & Miroslav L. Dukic, Mobile Datacom Networks, 1 5th Int'l Conf. on Telecom. in Modern Satellite, Cable and Broadcasting Service 123 (2001).
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
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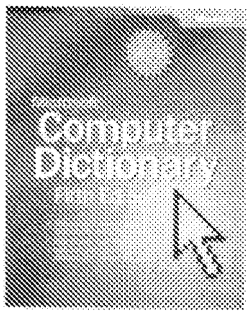

Microsoft® Computer Dictionary, Fifth Edition

By: Microsoft Press
Publisher: Microsoft Press
Pub. Date: May 1, 2002
Print ISBN-13: 978-0-7356-1495-6
Print ISBN-10: 0-7356-1495-4
Pages in Print Edition: 656
Amazon.com® Rating: (11 Ratings) Amazon.com® Reviews
Subscriber Rating: (0 Ratings)

Table of Contents

protected mode *n.* An operating mode of the Intel 80286 and higher microprocessors that supports larger address spaces and more advanced features than real mode. When started in protected mode, these CPUs provide hardware support for multitasking, data security, and virtual memory. The Windows (version 3.0 and later) and OS/2 operating systems run in protected mode, as do most versions of UNIX for these microprocessors. *Compare* real mode.

protocol *n.* *See* communications protocol.

protocol analyzer *n.* A management tool designed to identify and diagnose computer network problems. A protocol analyzer looks at LAN (local area network) or WAN (wide area network) traffic and finds protocol errors, connection delays, and other network faults. The protocol analyzer can filter and decode traffic, suggest solutions to problems, provide graphical reports, and show traffic by protocol and percent utilization. *See also* communications protocol.

protocol layer *n.* *See* layer.

protocol stack *n.* The set of protocols that work together on different levels to enable communication on a network. For example, TCP/IP, the protocol stack on the Internet, incorporates more than 100 standards including FTP, IP, SMTP, TCP, and Telnet. *See also* ISO/OSI reference model. *Compare* protocol suite.

protocol suite *n.* A set of protocols designed, usually by one vendor, as complementary parts of a protocol stack. *Compare* protocol stack.

prototyping *n.* The creation of a working model of a new computer system or program for testing and refinement. Prototyping is used in the development of both new hardware and software systems and new systems of information management. Tools used in the former include both hardware and support software; tools used in the latter can include databases, screen mockups, and simulations that, in some cases, can be developed into a final product.

proxy *n.* A computer (or the software that runs on it) that acts as a barrier between a network and the Internet by presenting only a single network address to external sites. By acting as a go-between representing all internal computers, the proxy protects network identities while still providing access to the Internet. *See also* proxy server.

proxy server *n.* A firewall component that manages Internet traffic to and from a local area network (LAN) and can provide other features, such as document caching and access control. A proxy server can improve performance by supplying frequently requested data, such as a popular Web page, and can filter and discard requests that the owner does not consider appropriate, such as requests for unauthorized access to proprietary files. *See also* firewall.

PrtSc key *n.* *See* Print Screen key.

.ps *n.* The file extension that identifies PostScript printer files. *See also* PostScript.

PS/2 bus *n.* *See* Micro Channel Architecture.

PSD *n.* A graphics file format used to create, modify, and display still images in Photoshop, a software application designed by Adobe Systems. PSD files have a file extension of .psd.

PSE *n.* *See* Packet Switching Exchange.

psec *n.* *See* picosecond.

pseudocode *n.* **1.** A machine language for a nonexistent processor (a pseudomachine). Such code is executed by a software interpreter. The major advantage of p-code is that it is portable to all computers for which a p-code interpreter exists. The p-code approach has been tried several times in the microcomputer industry, with mixed success. The best known attempt was the UCSD p-System. *Abbreviation:* pcode. *See also* pseudomachine, UCSD p-System. **2.** Any informal, trans-

Gospic, M.; Dukic, M.L.; , "Mobile datacom networks," *Telecommunications in Modern Satellite, Cable and Broadcasting Service, 2001. TELSIKS 2001. 5th International Conference on* , vol.1, no., pp.123-130 vol.1, 2001
doi: 10.1109/TELSKS.2001.954860
URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=954860&isnumber=20654

Mobile Datacom Networks

Milan Gospic[1], Miroslav L. Dukic[2]

Abstract- This paper presents new data communication networks, such as: GPRS, EDGE and 3G (UMTS), and new multimedia services through evolutionary concept of development. A common thing for this evolution is the IP (Internet Protocol). New network elements such as the Media Gateways, IP based BSS (Base Station System) and a new concept of the horizontally layered network are presented.

Keywords- WAP, GPRS, EDGE, UMTS, IP based BSS, Media Gateways.

I. INTRODUCTION

Mobile communication and data communication are two of the fastest growing areas in the communications industry. The major trend in mobile communicatons today is a Mobile Data Communications, which includes wireless Internet. The growth of the fixed Internet has created a mass market for multimedia and information services. In recent years, data traffic through the Internet has increased exponentially. IP (*Internet Protocol*) networks have expanded in size and speed. Customers are asking for advanced IP services, such as IP based virtual private networks (IP-VPN), voice over IP (VoIP), electronic commerce (*E-commerce*) and especially mobility. Mobile data communication combines mobile and data communications, thus giving consumers easy mobile access to information on the Internet and Intranets. All over the world, thousands of companies prepare for Mobile Internet by building the networks, designing the phones and developing the services. Operators are changing their networks to handle phone calls, Internet and video in one multi-service network, based on powerful data backbones and optical networks to deliver, for instance, voice, e-mail, Internet and video services on whichever device the user chooses.

In early stage of standardisation, GSM (*Global System for Mobile communications*) network was planed to support mainly speech service. By solving technical restrictions GSM network has developed through three evolutionary phases, named as phase 1, 2 and 2+. In phase 2+ three new systems are developed, which offers higher bit rates: *High Speed Circuit Switched Data* (HSCSD), *General Packet Radio Services* (GPRS) and *Enhanced Data rates for the GSM Evolution* (EDGE), Fig. 1.

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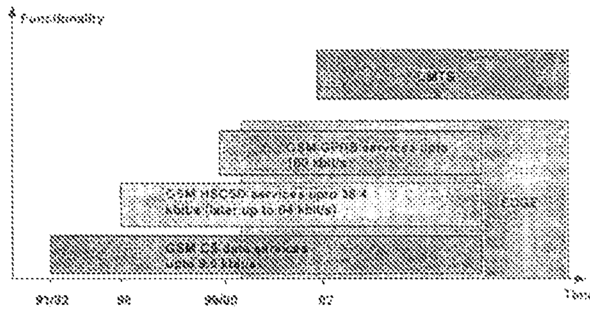

Fig. 1. GSM Data services evolution

II. WAP

Most of the technology developed for the data communications and Internet has been designed for desktop and larger computers and medium to high bandwidth, generally reliable data networks. Wireless networks and hand-held wireless devices present a more constrained computing environment compared to desktop computers, because of limitations of power and form-factor. Similarly, wireless data networks tend to have: less bandwidth, more latency, less connection stability, and less predictable availability. Also, Internet standards, such as HTML, HTTP and TCP are inefficient over mobile networks.

The first solution, which enabled mobile datacom, in standard GSM network, was introduction of WAP (*Wireless Application Protocol*). The objective of WAP is to provide access via a mobile device to the Internet or Intranets. It is an open and global standard that has been optimised for mobile environments and provides data-oriented (non-voice) services. WAP integrates telephony services with micro-browsing and enables easy to use interactive Internet access from the mobile handset, using WML Script (Wireless Markup Language).

The WAP content types and protocols have been optimized for wireless environment. WAP utilizes proxy technology to connect between the wireless domain and the WWW. The WAP proxy, Fig. 2, typically is comprised of the following functionality:

- Protocol Gateway. The protocol gateway translates requests from the WAP protocol stack (WSP, WTP, WTLS, and WDP) to the WWW protocol stack (HTTP and TCP/IP).

- Content Encoders and Decoders. The content encoders translate WAP content into compact encoded formats to reduce the size of data over the network.

The WAP proxy allows content and applications to be hosted on standard WWW servers and to be developed using proven WWW techologies.

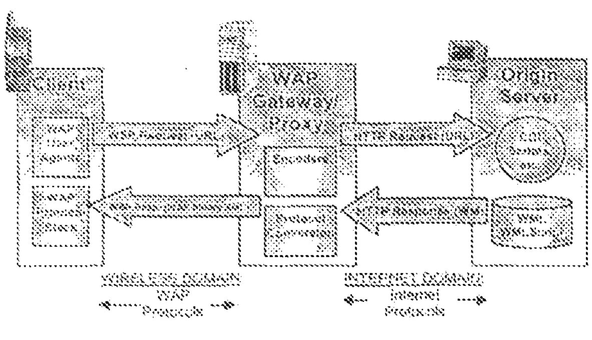

Fig. 2 WAP Gateway.

Present-day WAP services use two different bearer services: circuit-switched data (CSD) and short message service (SMS), each significantly limited (e.g. set-up time for CSD or low bandwidth of SMS). The deployment of a new system, named *General Packet Radio Service* (GPRS) will eliminate delays and offer much greater bandwidth.

III. GPRS

General Packet Radio Services (GPRS) is a standardized packet switched (PS) data service for GSM based systems. GPRS introduces packet data transmission all the way to the mobile subscriber, and is being designed to work within the existing GSM infrastructure with additional packet switching nodes: the *Serving GPRS Support Node* (SGSN) and the *Gateway GPRS Support Node* (GGSN).

The GPRS system provides a basic solution for Internet Protocol (IP) communication between Mobile Stations (MS) and Internet Service Hosts (IH) or a corporate LAN. This is done with:

- Efficient use of radio resources
- A flexible service, with volume-based (or session duration-based) billing
- Fast set-up/access time
- Efficient transport of data packets in the GSM network
- Simultaneous GSM and GPRS, co-existence without disturbance
- Connectivity to other external packet data networks, using the IP

In standard GSM network, access to the public packet data network is provided with the circuit switched (CS) GSM bearer service. This means that a connection will be used for the total duration of a session, even when no data is sent. GPRS data transfer is based on the Internet Protocol (IP). The packet data transmission is thus carried out on an end-to-end basis, including the air interface. While the GSM System uses circuit switching air interface for telephony, the GPRS system uses packet switching air interface, both according to the GSM standard. A GPRS network can be seen as an extension to a GSM network and requires some additions specific to the GPRS network. By introducing the GPRS system into the GSM System, it is possible to coordinate, attach, authenticate and handle subscriber and terminal data for both circuit-switched and packet-switched communication. GPRS adds a packet switching functionality to the GSM system, with the possibility to send data packets with a transmission rate up to 115 kbit/s. The GPRS Architecture utilizes the existing GSM nodes and adds new ones, for handling of packet switching, point to multipoint service handling and interworking with existing packet data networks.

The GPRS system is characterized by the fact that a radio channel is shared between several MSs. No radio channels are allocated to the MSs. When an MS generates a data packet, the network forwards it on the first available radio channel, and one MS will be able to use up to four (later up to eight) radio time slots simultaneously. When a message, consisting of large data quantities, is to be transferred it is divided into several packets. When these packets r ach the addressee, they are reassembled to form the original message. All the received packets are stored in data buffers. The GPRS user may remain connected to the accessed data network as long as desired, but only need to be charged for the data volume received and/or sent.

The basic idea of a GPRS network is to offer a logical channel for packet transmission between GGSN and the GPRS subscriber via the SGSN serving the geographical area the subscriber is currently located. The nodes are interconnected via a backbone network, that is a Internet Protocol (IP) network. The SGSN and GGSN functionality may be combined in the same physical node, or they may reside in different physical nodes. SGSN and GGSN contain GPRS backbone network protocol (IP) routing functionality, and they may be interconnected with IP routers.

An overview of the GPRS system architecture integrated with the CS part of GSM system is shown in Fig. 3. Primary components are two new PS nodes: SGSN and GGSN.

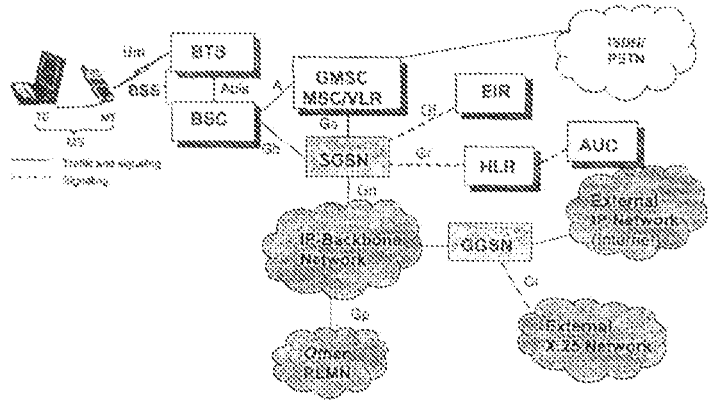

Fig 3 GPRS System.

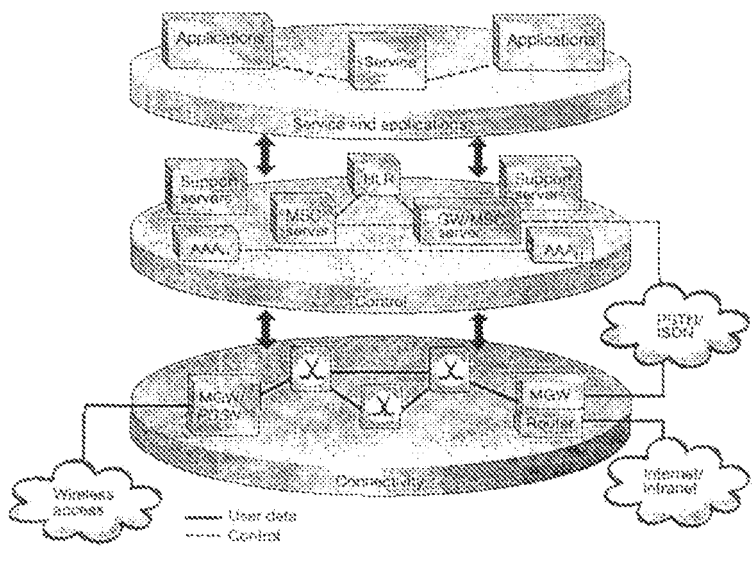

Fig. 4 UMTS Architecture

IV. EDGE

The Enhanced Data rates for Global Evolution (EDGE) system, which is a new time-division multiplexing-based radio-access technology, gives GSM and TDMA an evolutionary path for delivering third-generation services in the 800, 900, 1800 and 1900 MHz frequency bands. The advantages of EDGE include rapid availability, the reuse of existing GSM and TDMA infrastructure, and support for gradual introduction.

EDGE can be seen as a generic air interface for efficiently providing high bit rates. It thus facilitates an evolution of existing cellular systems toward third-generation capabilities. EDGE introduces higher level modulation and new coding schemes for PS and CS data communication. In addition to GMSK modulation used for GSM, EDGE introduces eight-symbol phase-shift-keying (8PSK) modulation. The introduction of EDGE increases maximum bit rates to approximately three times that of standard GPRS.

EDGE mainly affects the radio-access part of the network, BTS and BSC in GSM, but does not have a negative effect on applications and interfaces based on CS and PS access. Existing network interfaces are retained through the MSC and SGSN. The basic idea involves reusing regular GSM (and GPRS) data services, but with increased bit rates. By reusing the GPRS core network structure, packet-data services can be provided with an air-interface bit rate that ranges from 11.2 to 69.2Kbps per time slot. CS services are supported with an air-interface bit rate up to 28.8Kbps per time slot. Multislot operation, which is supported for all services, yields eight times the bit rate provided by a single time slot, and a peak air-interface bit rate of 554Kbps for packet data.

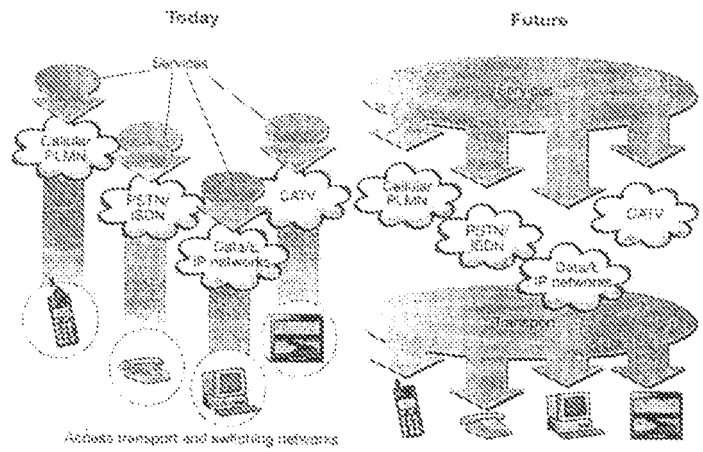

Fig. 5. Vertical and Horizontal architecture.

V. UMTS

The UMTS network will be a multi-service "network of networks". It will accommodate the growing number of interconnections between a variety of networks, circuit and packet-switched, narrowband and broadband, voice and data, fixed and mobile.

As originally decided by ETSI SMG, the 3GPP release 99, core network standard is evolved from earlier GSM standards releases. The core network forms a central part of a PLMN (Plain Land Mobile Network) and accommodates important functions for intra and inter PLMN roaming, provision of IP-connectivity and Internet access, ISDN services, interworking with other networks, provision of billing and accounting information etc, Fig. 4.

The core network may logically be looked upon as consisting of two different parts. One part managing circuit mode communication services (ISDN type of services) and one part, the GPRS part, managing packet mode communication (provision of IP connectivity). Although logically very different the two parts share certain core network functionality (HLR, AUC, EIR etc.) and may run over a common transport infrastructure. The UMTS core network supports both circuit and packet-switched services and contains the hardware and the software to provide end-users with multimedia applications. In creating of core network, a layered architecture has been developed consisting of the control and the connectivity domains. The layered core network architecture is derived from the current standards reference model by separating the control plane functions in the MSC(Mobile Switching Centre) and the SGSN from their user plane functions, thus turning these nodes into Servers and Media Gateways as illustrated in Fig. 4, thus the solution could also be referred to as a Server/Media Gateway architecture. The Service Network (Application layer) is the third layer on top of the two core network layers. Information is transported in the connectivity layer, which consists of Media Gateways (MGW) as edge nodes, interconnected by switches or routers. The control layer controls the switching and transport of traffic through the media gateways. Interfaces between the layers will become open and standardised. The division between the control and connectivity layers allows flexibility in the selection of transport technologies, such as asynchronous transfer mode (ATM) and Internet protocol (IP). Connected networks, such as the Internet, ISDN and PSTN networks and access networks such as the GSM base station system and the UMTS Radio Access Network, can therefore be based on different transmission and signalling technologies. Media Gateway (MGW) nodes will adapt and link these networks to the backbone network.

Today's tele and data communications environment consists of a variety of networks. Most of these networks are highly specialized, designed and optimized to serve a specific purpose. To a large extent these networks can also be described as "vertically integrated". The separation of the network functions into independent layers is a key principle in modern networking, and is sometimes identified as one of the key success factors for the IP technology. The UMTS layered core network allows operators to develop new opportunities, while simultaneously managing the migration of existing service portfolios and network investments. This capability is supported by a open-ended, distributed architecture of the service layer. The move to a horizontal integration of services creates an open environment for the design and execution of applications, and provides open access to underlying capabilities. In short the solution is based on a horizontalisation of the network into a number of independent layers. Media Gateways (MGW), controlled by specific network servers, adapt and connect different access types to a common backbone network. A specific service layer, common to different access types, provides end-user applications. Fig. 5, illustrates vertically and horizontally layered networks. This layered architecture, today generally pursued by most standardization forums, provides an inherent flexibility which allows operator to build scalable and cost effective multi-services solutions.

5.1 Control layer

The control plane houses a number of network servers and databases of different types (MSC Server, SGSN Server, HLR, AUC, EIR etc.). These servers are responsible for handling subscriber data, security, mobility management, setup and release of calls and sessions requested by the end-users, circuit mode supplementary services and similar functions. Communication between the servers and other networks is provided by standard protocols. The MSC and SGSN servers determine what media gateway functions and resources are required by the call/session— and control them via the gateway control protocol. The SGSN server determines and controls end-user Internet protocol services and mobility management. The MSC server handles call control for CS calls and controls CS related resources in the media gateway. It provides circuit-switched services, including tele, bearer and supplementary services, charging and security. In addition, the MSC server provides mobility management and connection management. The Home Location Register (HLR) stores all subscriber data in real-time and plays an integral role in the set-up of calls and tracks the roaming of subscribers.

5.2 Connectivity layer

The connectivity layer, sometime also referred to as the user plane, could be seen as a layer of distributed resources for managing user data (and signaling) flows. The user plane functions are primarily handled by the GGSNs and the MGWs, located at the edges of the core network. The MGW carries out the processing of end-user data (speech coding, echo canceling, multiparty bridging, packet forwarding, protocol mapping, QoS mapping etc) and also acts as an access switch/router to the backbone network. The MGW is also responsible for setting up the bearer connections carrying the user data flows in the user plane. The MGWs are controlled by the MSC and SGSN servers. The connectivity layer uses media gateways to process end-user data, such as coding/decoding, echo canceling, multi-party bridging, protocol conversion and Quality of Service mapping. The media gateway node also serves as a gateway to the backbone switches and routers and is responsible for setting up the bearer connections carrying the user data flows in the user plane. The MSC and SGSN servers control the media gateways via a gateway control protocol. The main purpose of the media gateways is to provide the necessary functionality for manipulating the connectivity layer at the borders with different networks. The media gateway functions as a transport mechanism that is independent of services and applications. At the same time, it emulates the protocols and signaling required for continuous service provision. The media gateway thus simplifies bridging between different networks and ensures service performance. The GGSN node provides connectivity to external networks and controls Internet protocol tunneling in the backbone network. The connectivity layer is open to different transport technologies, such as STM, ATM or IP. Initially ATM is expected to be the primary choice because of its Quality of Service support, enabling an efficient sharing of transmission bandwidth between delay sensitive traffic, e.g. voice, and best effort packet data. If ATM is chosen as the initial transport technology, a future migration to IP is straightforward. The Media Gateways, as well as the RBS's and the Radio Network Controllers (RNC), are based on the same platform as the real time IP router. That means that a large part of the hardware can be re-used.

5.3 Application Layer

The application layer is a simplified abstraction of the layer where most of the end-user applications reside. To a large extent these applications are implemented partly in the terminals and partly in specific application servers in the network. Applications exist in a broad variety, from very simple end-to-end client/server solutions to very complex applications involving multiple interactive end-systems, networks, media, communication models etc. The service network is the melting pot for all types of end-user services, such as call control communication services, information services, multimedia services, positioning services, and Internet access. It is also the convergence place for services applicable for other types of networks, and the place where most of the virtual home environment will be implemented. Although the service network is logically separated from the rest of the PLMN, its IP infrastructure may be shared between the core network and the service network domains. It offers open interfaces to service capability servers and application support servers.

5.4 Media Gateway

The architecture of UMTS network changes the current vertically specialized network (where different applications have their own access, transport, and control nodes for traffic handling) into a horizontally layered structure. The layering means in practice that the different levels in network hierarchy are separated, and communicate over well-specified interfaces, thus different applications can share the resources in the lower levels of the network. The Media Gateway (MGW) is located on the Connectivity Layer, and manipulates the network resources, as instructed by the MSC or SGSN servers located in the Control Layer of the network, Fig. 6. The MGW and servers communicate using the Gateway Control Protocol (GCP).

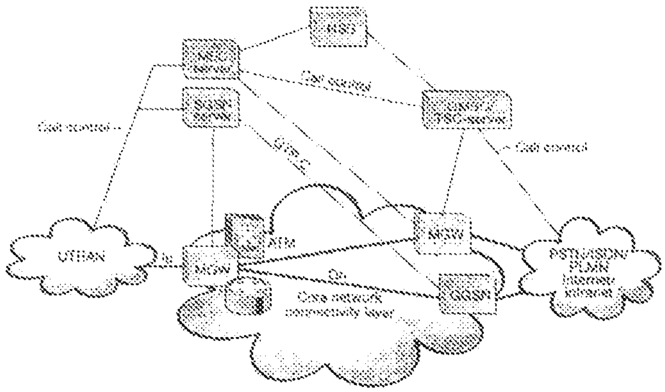

Fig. 6. MGW

The Media Gateway can be configured to function as one or any combination of the following.

* ATM Switch;
* Packet Data Handler;
* Embedded Real Time IP Router;
* Media Stream Handler

The Media Gateway is a self-contained network element that provides all the necessary functionality for modifying the Connectivity Layer at the borders between different networks. It can contain a full set of speech and data resources for performing modification and additions to the Connectivity Layer. It also contains transport resources for performing protocol and Connectivity Layer conversions between different networks, and provides Signaling Gateway functionality for performing conversions of lower layer control protocols. An incoming connection on a physical line interface with a standardized bearer protocol is connected to the appropriate function. On the egress side it is connected to an outgoing standardized bearer. Thereby an incoming bearer is switched to an outgoing bearer even if the stream is modified and the bearers are changed. In this process, conversion between different bearers and formats can be made. This conversion can for example mean converting compressed voice to non-compressed format and changing bearer from ATM to STM.

For packet based traffic the Media Gateway performs functions such as:

* SGSN payload handling
* QoS handling
* IPSec function for secure transmission between packet core network nodes.

The external control interface is the Gateway Control Protocol used by the MSC Server to request the Media Gateway to add and remove media stream functions into a speech and data connection. The Gateway Control Protocol is used by the SGSN Server to e.g. request the Media Gateway to establish, release and maintain a PDP context for a packet data subscriber. In the process to establish and release a connection to other network nodes the relevant bearer signaling is included. A Media Gateway can lend its resources to any MSC or SGSN Server; an MSC or SGSN Server can use the resources of any Media Gateway.

Key benefits of the Server/Media Gateway architecture are:

* Handling circuit and packet traffic on a common transport and switching/routing infrastructure provides lower transmission and infrastructure cost.
* Re-use of investment in the GSM infrastructure. The layered core network architecture permits re-use of GSM MSCs and GSNs as part of the UMTS solution.
* Placing the codec on the edge of the network enables encoded speech to be transmitted across the core network, resulting in transmission savings.
* Centralizing devices, i.e. forming larger pools of devices enables more efficient use of resources.

5.5 Radio Access Network

Radio Access Network can consist of two systems: second generation access network ERAN (*EDGE Radio Access Network*) and third generation access network UTRAN (*UMTS Terrestrial Radio Access Network*).

The UTRAN radio access network consists of the following, Fig. 7 :

* Radio Network Controllers (RNC). The RNC manages radio access bearers for user data transport, and controls mobility.
* Radio Base Stations (RBS). The RBS provides the actual radio resources and maintains the radio links.
* Radio Access Network Operation Support (RANOS). RANOS is a suite of software that is designed to support the day to day operation and maintenance tasks for the WCDMA RAN.
* Tools for Radio Access Management (TRAM). TRAM is a PC-based concept that contributes to a fast, smooth WCDMA radio access network deployment. TRAM supports the design, monitoring and performance management of the radio and transport networks.

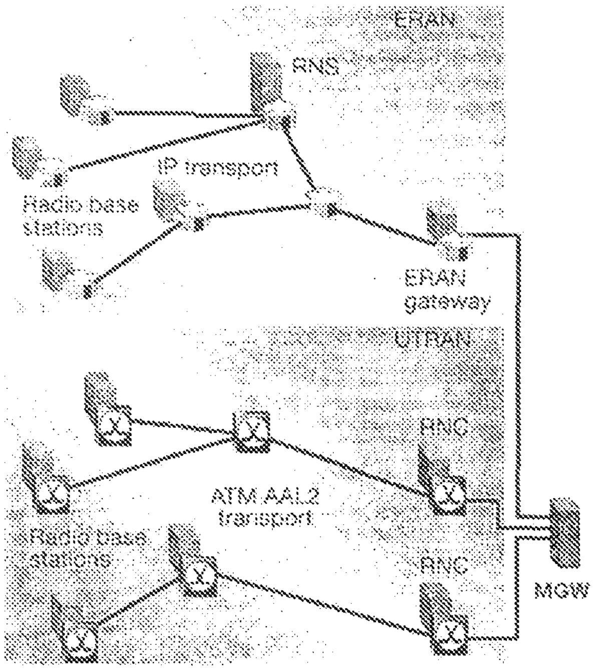

Fig. 7. The Radio Access Network.

Each node contains IP routing functionality for the RAN management Intranet, which means that they are accessible from any place with an access to the IP network, such as any RBS or RNC node. No separate management transport links are required since the IP network can be carried over the same physical links as the user data.

The UTRAN functionality can be divided into four areas:

* Radio access bearer functionality
* Radio network control functionality
* Transport network control functionality
* Operation and maintenance functionality

ERAN-Internet protocol-based base station system (IP BSS) is built on a server-gateway architecture and supports standard GSM services and air interface protocols, and connects to the core network via standard interfaces. It supports both GSM BSS and TDMA-EDGE radio access networks. The IP BSS consists of five main parts, Fig. 7:

1. The Radio Network Server (RNS) handles all radio network logic and call control (selection of cells and channels). No payload data is routed through the RNS, Fig. 8. It is responsible for:
    * Setting up and releasing connection between a MS and MSC
    * Coordinating the assignment of traffic channels
    * Controlling handover
    * Distributes paging to all cells belonging to BSC area

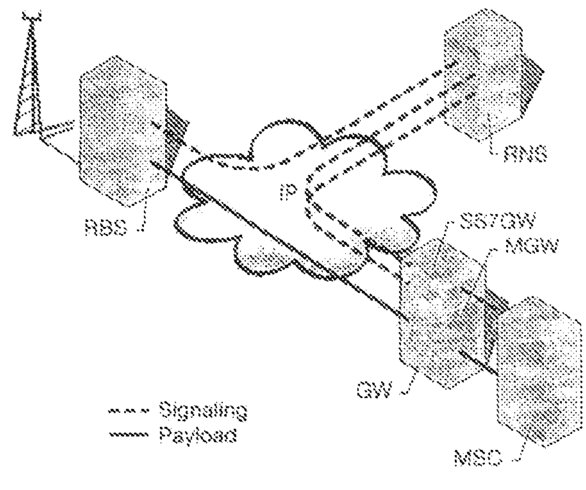

Fig. 8. RNS.

2. The Radio Base Station (RBS). RBS includes radio transmission and reception functions for the air interface. It is controlled by the RNS. The voice payload is sent to the Gateway. The RBS also included an embedded IP router for packet distribution and can be used for cascade configuration of several RBSs.

3. BSS Gateway. It is composed of a media gateway and a signaling system no.7 gateway.

4. The real-time IP network. The IP network handles all routing in the system. The IP network uses real-time IP routers that have been optimized for the requirements of wireless data and voice traffic. Real-time routers must be introduced to provide the necessary transport of real-time services and they are:
    * Able to differentiate between high and low priority packets
    * Free of internal congestion
    * Contain mechanisms that prevent large packets with low priority from blocking small packets with high priority

5. The operation and maintenance system

VI. Conclusion

By evolving from standard GSM network, today mobile datacom network enables more reliable transmission and higher bit rates, but still not offering fully open-standard environment. The future mobile networks will be based on horizontal layering, which enables open and distributed network architecture, thus creating an open environment for design and execution of applications, supported by common transport backbone network offering high bit rates and reliable connections based on different transport technologies.

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